



December 1, 2016

Supplemental Report by John W. Carson, Ph.D.

concerning

**Failure of a soybean meal silo supplied by Sioux Steel to Agropecuaria
el Avión plant in Tepic, Nayarit, Mexico**

Report 70622-2

I. BACKGROUND

Since submitting my Expert Report on November 21, 2016, I received the plant's surveillance video along with about 200 pages of documents. I found that the documents were mostly duplicates of ones that I had previously reviewed. This report, which supplements my previous report, focuses primarily on my analysis and conclusions from the video, which I had not seen previously.

II. VIDEO

Using the coordinate system described by Rodent Nohr in his March 3, 2015 report, I determined that the video camera was directed more or less due south.

The video starts at time stamp 07:35:02 on February 2, 2015. I analyzed the video second-by-second until about ¼ sec. before the silo failed. I then analyzed it frame-by-frame. I was able to determine that there were 25 frames/sec., so each frame represents 0.04 sec.

Table 1 documents my analysis of the video. The first seam to fail was on the northwest, and the second to fail was on the northeast.

3485 Empresa Drive
San Luis Obispo, CA 93401
Tel: 805-541-0901

400 Business Park Drive
Tyngsboro, MA 01879
Tel: 978-649-3300

810 Hwy 6 South, Ste 231
Houston, TX 77097
Tel: 281-921-1998

info@jenike.com

Jenike & Johanson

www.jenike.com

**Table 1. Analysis of video of silo collapse**

Time	What happened	Frame #	Comment
35:02	Start of video		
35:15	First worker visible		
36:06	Worker starts hammering on right side of lower cone, total of four blows		
36:40	Large puff of dust near right side of outlet		34 sec. after worker started hammering
37:21	Large puff of dust near right side of outlet		41 sec. between puffs
38:17	Small puff of dust near right side of outlet		56 sec. between puffs
38:34	Small puff of dust near right side of outlet		17 sec. between puffs
38:52	Small puff of dust near right side of outlet		18 sec. between puffs
39:03	Worker appears at right		
39:24	Small puff of dust near right side of outlet		32 sec. between puffs
39:26	Worker on right points up to mid-section of hopper		
39:29	Second worker runs to left behind hopper		
39:33.24	Screen shots start	200	25 frames/sec.
39:33.48	Material starts coming out in lower half of hopper along northwest seam	206	9 sec. after last puff
39:33.52	Material starts coming out in upper half of hopper along same northwest seam	207	0.04 sec. after material in lower half starts coming out
39:33.68	Material starts coming out in upper half of hopper along northeast seam	211	0.20 sec. after material starts coming out along seam #4
39:33.76	Reclaim conveyor starts to move upward	213	0.08 sec. after second seam starts to leak material

In reviewing the various photos of the silo after it failed I numbered the seams #1 through 20 starting with the seam adjacent to the cylinder air cannon on the northeast side as #1 and proceeding counterclockwise when looking down on the silo. Using this numbering scheme I was able to identify the first failed seam as seam #4 and the second as seam #20. See Figures 1 and 2.

III. CONCLUSIONS

From my analysis of the video and other documents, I conclude to a reasonable degree of engineering certainty:

1. The silo started to fail in the lower portion of one of the northwest hopper seams, most likely what I have denoted as seam #4. Within 0.04 sec. of the start of this failure the upper portion of this seam started to fail. This was followed by failure in the upper portion of one of the northeast seams, most likely what I have denoted as seam #20.



2. The air cannons appear to have been fired on a 16 to 20 sec. interval, which is consistent with Mr. Nohr's description of their operation and inconsistent with the Pneumat documents.

3. Not every firing of an air cannon resulted in puffs of air and fine soybean meal particles near the hopper outlet. This is undoubtedly because of the location of individual air cannons relative to the outlet and relative to the location of a void (arch or rathole) within the silo.

4. The initial failure was almost directly below one of the air cannons in the cylinder section. Firing this air cannon likely resulted in greatly increased (compared to gravity alone) pressures on the hopper wall.

5. As I noted in my previous report, the hoop stresses generated by gravity-induced pressures acting on the hopper walls were considerably smaller in the lower portion of the hopper than higher up. Since the silo failed in the lower portion of one seam, the loads that caused the failure were therefore far greater than those imposed by gravity alone. KC's lack of review of the hopper seams thus had no bearing on the silo failure.

I reserve the right to modify and amend my opinions as additional information becomes available and to issue rebuttal opinion in response to the opinions of other experts.

Respectfully submitted,

A handwritten signature in cursive script, reading 'John W. Carson', written over a horizontal line.

John W. Carson, Ph.D.
President
Tyngsboro, Massachusetts

jwcarson@jenike.com

seam #4

seam #1

seam #20



Fig. 1 Photo PLF 624

seam #4

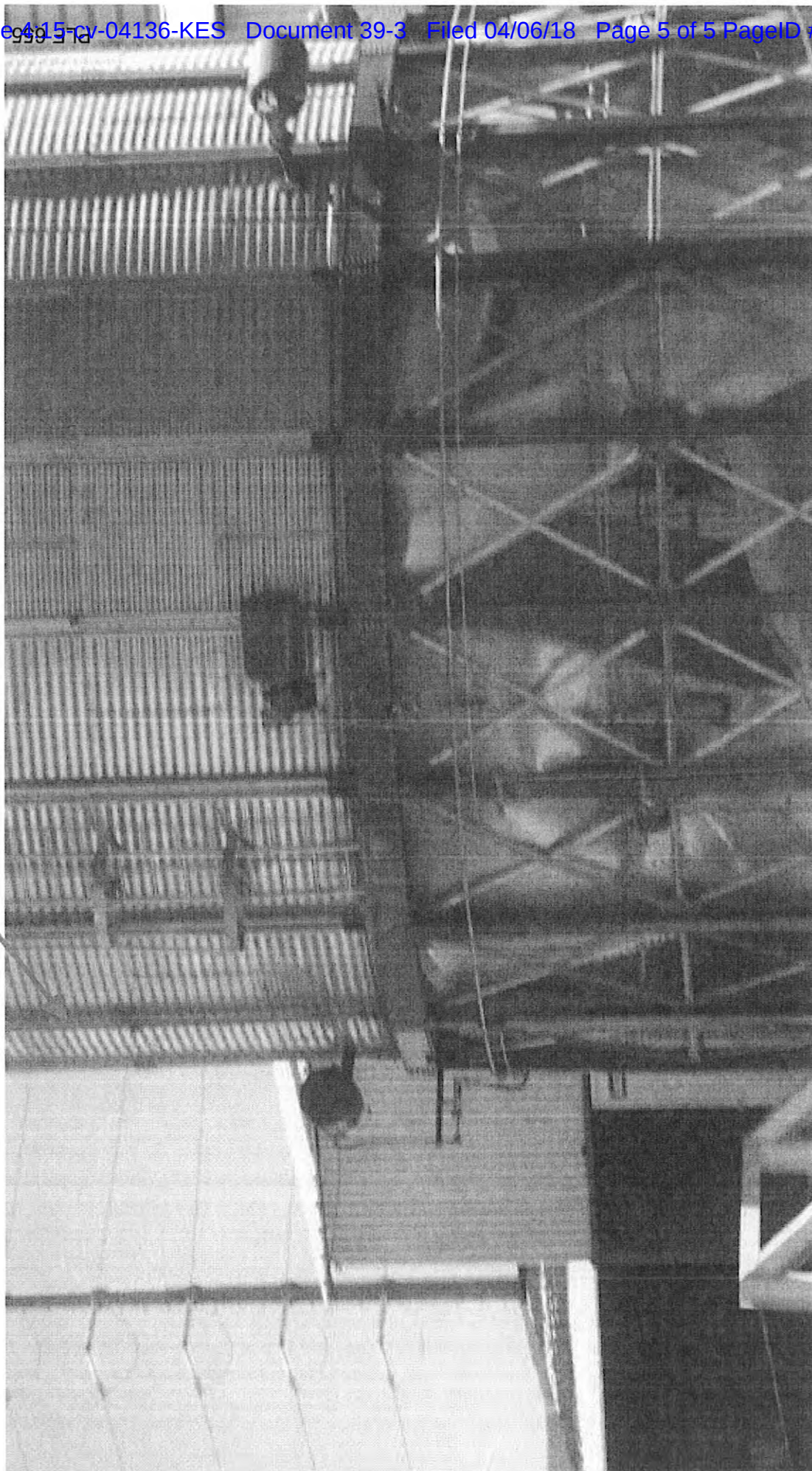


Fig. 2 Photo PLF 655